



**University of
Zurich**^{UZH}

**Zurich Open Repository and
Archive**

University of Zurich
University Library
Strickhofstrasse 39
CH-8057 Zurich
www.zora.uzh.ch

Year: 2015

Effects of a Physical Activity Intervention in Preschool Children

Roth, Kristina ; Kriemler, Susi ; Lehmacher, Walter ; Ruf, Katharina C ; Graf, Christine ; Hebestreit, Helge

Abstract: **PURPOSE** To evaluate a multi-component, child-appropriate preschool intervention program led by preschool teachers to enhance physical activity (PA) and motor skill performance (MS) in 4- and 5-year old children. **METHODS** Evaluation involved 709 children (mean age 4.7 ± 0.6 years; 49.5% girls) of 41 preschools (intervention group $n=21$; control group $n=20$) in the rural and urban surroundings of two German cities. Children in the intervention group received a daily PA intervention lasting 30 minutes, and PA homework over one academic year designed by professionals, but led by preschool teachers. The intervention included educational components for parents and teachers. Primary outcomes were MS (composite motor skill score) and objectively measured moderate-to-vigorous physical activity (MVPA) by accelerometry. Measurements were performed at baseline, mid- and post-intervention, and 2 to 4 months after end of intervention. Intervention effects were analyzed by repeated measurement analysis adjusted for "group", sex, age, baseline outcomes, urban/rural location of the preschool, and cluster (preschool). **RESULTS** Compared to controls, children in the intervention group showed positive effects in MS at post-intervention (estimate effect: 0.625 z-score points, 95% confidence interval (CI): 0.276 to 0.975, $p=0.001$) and at follow-up (estimate effect: 0.590 z-score points, 95% CI 0.109 to 1.011, $p=0.007$), and an increase in MVPA from baseline to post-intervention by 0.5% of total wearing time (95% CI: 0.002% to 1.01%; p -value: 0.049) at borderline significance. There was no benefit on MVPA for the intervention group between baseline and follow-up. **CONCLUSIONS** A child-appropriate, multidimensional PA intervention could sustainably improve MS, not PA. Findings suggest that a change of health related behaviors is difficult. Future research should implement participatory intervention components in preschool setting and better integrate the families of the children.

DOI: <https://doi.org/10.1249/MSS.0000000000000703>

Posted at the Zurich Open Repository and Archive, University of Zurich

ZORA URL: <https://doi.org/10.5167/uzh-110991>

Journal Article

Published Version

Originally published at:

Roth, Kristina; Kriemler, Susi; Lehmacher, Walter; Ruf, Katharina C; Graf, Christine; Hebestreit, Helge (2015). Effects of a Physical Activity Intervention in Preschool Children. *Medicine and Science in Sports and Exercise*, 47(12):2542-2551.

DOI: <https://doi.org/10.1249/MSS.0000000000000703>

Medicine & Science IN Sports & Exercise

The Official Journal of the American College of Sports Medicine

www.acsm-msse.org

. . . Published ahead of Print

Effects of a Physical Activity Intervention in Preschool Children

Kristina Roth¹, Susi Kriemler², Walter Lehmacher³, Katharina C Ruf¹,
Christine Graf⁴, and Helge Hebestreit¹

¹University Children's Hospital, Julius-Maximilians-University Wuerzburg Wuerzburg, Germany; ²Epidemiology, Biostatistics and Prevention Institute, University of Zuerich, Zuerich, Switzerland; ³Institute of Medical Statistics, Informatics and Epidemiology, German Sport University Cologne, Cologne, Germany; ⁴Institute of Theory and Practice of Training and Movement, German Sport University Cologne, Cologne, Germany

Accepted for Publication: 29 April 2015

Medicine & Science in Sports & Exercise, **Published ahead of Print** contains articles in unedited manuscript form that have been peer reviewed and accepted for publication. This manuscript will undergo copyediting, page composition, and review of the resulting proof before it is published in its final form. Please note that during the production process errors may be discovered that could affect the content.

Effects of a Physical Activity Intervention in Preschool Children

Kristina Roth¹, Susi Kriemler², Walter Lehmacher³, Katharina C Ruf¹,
Christine Graf⁴, and Helge Hebestreit¹

¹University Children's Hospital, Julius-Maximilians-University Wuerzburg Wuerzburg, Germany; ²Epidemiology, Biostatistics and Prevention Institute, University of Zuerich, Zuerich, Switzerland; ³Institute of Medical Statistics, Informatics and Epidemiology, German Sport University Cologne, Cologne, Germany; ⁴Institute of Theory and Practice of Training and Movement, German Sport University Cologne, Cologne, Germany

Running title: Physical activity intervention in children

Corresponding author

Dr. Kristina Roth
University Children's Hospital
Josef-Schneider-Str. 2
97080 Wuerzburg
Tel.: +49 931-201 27101
Fax: + 49 931-201 27242
Email roth_k1@ukw.de

The authors declare that the institution of HH, KCR and KR had financial support from the German Federal Ministry of Education and Research (BMBF) (Grant Nr. 01EL0606, BMBF) and from the BARMER GEK (formerly Gmuender Ersatz-Kasse GEK) for the submitted project. The funders had no role in study design, data collection and analysis, decision to publish, or preparation of the manuscript. There are no financial relationships with any organizations that might have an interest in the submitted work in the previous three years, and no other relationships or activities that could appear to have influenced the submitted work. We declare that the results of our study do not constitute endorsement by ACSM.

Abstract

Purpose: To evaluate a multi-component, child-appropriate preschool intervention program led by preschool teachers to enhance physical activity (PA) and motor skill performance (MS) in 4- and 5-year old children. **Methods:** Evaluation involved 709 children (mean age 4.7 ± 0.6 years; 49.5% girls) of 41 preschools (intervention group $n=21$; control group $n=20$) in the rural and urban surroundings of two German cities. Children in the intervention group received a daily PA intervention lasting 30 minutes, and PA homework over one academic year designed by professionals, but led by preschool teachers. The intervention included educational components for parents and teachers. Primary outcomes were MS (composite motor skill score) and objectively measured moderate-to-vigorous physical activity (MVPA) by accelerometry. Measurements were performed at baseline, mid- and post-intervention, and 2 to 4 months after end of intervention. Intervention effects were analyzed by repeated measurement analysis adjusted for “group”, sex, age, baseline outcomes, urban/rural location of the preschool, and cluster (preschool). **Results:** Compared to controls, children in the intervention group showed positive effects in MS at post-intervention (estimate effect: 0.625 z-score points, 95% confidence interval (CI): 0.276 to 0.975, $p=0.001$) and at follow-up (estimate effect: 0.590 z-score points, 95% CI 0.109 to 1.011, $p=0.007$), and an increase in MVPA from baseline to post-intervention by 0.5% of total wearing time (95% CI: 0.002% to 1.01%; p -value: 0.049) at borderline significance. There was no benefit on MVPA for the intervention group between baseline and follow-up. **Conclusions:** A child-appropriate, multidimensional PA intervention could sustainably improve MS, not PA. Findings suggest that a change of health related behaviors is difficult. Future research should implement participatory intervention components in preschool setting and better integrate the families of the children.

Key words: Motor skill performance, moderate-to-vigorous physical activity, preschool, obesity

Introduction

Poor motor skills and low levels of physical activity are major public health concern in children for several reasons: Insufficient fundamental movement skills in early childhood are associated with poor self-perception (40), reduced cognitive abilities like linguistics and mathematics (32), and an increased frequency of accidents (20). Furthermore, deficient motor development in early years has even been linked to anxious and depressive behavior at school age (30) and less engagement in physical activity during adolescence (3). On the beneficial side, fundamental motor skill competency is positively associated with cardiovascular fitness and negatively with weight status in childhood (25). Likewise, a high level of physical activity is beneficial for health status even in early years (9, 38).

There is a widespread call for effective intervention strategies for preschoolers targeting motor skills and/or physical activity behavior to prevent the development of health risks during childhood (9, 25, 33). Since motor skill performance and physical activity are interlinked at this age (44) interventions may target either of the two or both.

A number of physical activity intervention trials showed that enhancing physical activity and/or motor skills is possible in a preschool setting (42). Yet, most trials used an intervention shorter than one academic preschool year and no follow-up assessment took place after the end of the intervention (1, 4, 12, 14, 18, 24, 26, 33). It is thus uncertain whether such interventions could induce some persisting beneficial effects. Furthermore, most studies employed intervention contents that were highly standardized and/or designed to improve aerobic fitness rather than motor skills. It has been recognized that mechanism underlying physical activity engagement and special motor skill development in preschool children are different from child to child (37, 47). Thus, an intervention allowing individualized components based on developmental psychology

and participatory principles might be more effective, especially in the long run. Third, some of the reported interventions required extra staff and were, thus, costly. Enabling the preschool teachers to provide the intervention after some training may allow better compliance from the teacher's side and an easier implementation of the program after the end of the study period.

The objective of the present study was therefore to evaluate a multi-dimensional child appropriate preschool program, which can easily be implemented in preschools of different sizes and variable equipment and be performed by the preschool teacher. Using a cluster-randomized controlled design, we expected significant benefits of the intervention on physical activity and motor skill performance in 4- and 5-year old preschool children.

Materials and methods

Design and study population

The Prevention through Activity in Kindergarten Trial (PAKT) is a cluster randomized controlled trial conducted in the cities and counties of Wuerzburg and Kitzingen, two regions in the south of Germany with an observed high incidence of obese children at school entry age prior to the start of the project (23). The study design and the recruitment into the study have been described in detail elsewhere (34). Briefly, recruitment started in autumn 2006 with an invitation of all preschools in the respective area, except those with a special focus on physical activity promotion concept. Preschools recruited for this study are institutions that are attended by children aged 3 to 6 years old. In some of these institutions, children are organized in groups that are usually not matched by age. Some other institutions have open concepts, where children play without being in a certain group but where groups are formed according to certain activities. In this study, children were not recruited on the level of groups or classes, but throughout the whole

preschool. 41 out of 131 consenting preschools were selected for the study. Parents of 979 eligible children at the age of 4.0 up to 5.9 years at start of the intervention, which took place between September 2007 and July 2008, were invited to join the study. The study was approved by the Ethics Committee of the Medical Faculty of the University of Wuerzburg.

Informed consent was obtained from 764 children. 55 children had to be excluded as they did not meet inclusion criteria (health conditions, age) or were not willing to participate in the baseline assessments. A total of 709 (out of 979) eligible children (72% participation rate) in 41 preschools were randomly assigned to a control (341 children in 20 clusters) or an intervention group (368 children in 21 clusters). Figure 1 and 2 provide the sample size information throughout the trial, and for each outcome measure respectively. The data of 664 children (94% of the sample) could be analyzed for effects of the intervention and 610 children (86%) participated in the follow-up assessments two to four months after the end of the intervention.

Randomisation and blinding

After baseline assessments, preschools were randomized into intervention group (IG, n=21) and control group (CG, n=20) using a computer generated random number table stratified for urban (n=9) or rural location (n=32). To minimize contamination, randomization was done at the level of preschools and not on individual level. Randomization was performed by a person blinded to the identity of the preschool. Children of the control group were not informed about the existence of the intervention program in other preschools. The parents and teachers of the control group knew about the intervention arm, but were not informed about its content. Preschools in the control group continued their routine schedule with their common daily activity and weekly

physical activity class they used to run before participating in the study, but without formal motor skill teaching and without promotion of physical activity.

Intervention

The design and components of the intervention have been described in detail previously (35). Briefly, the intervention was offered over one academic preschool year (about 11 months). It was developed by physical education scientists, pediatricians, dieticians and a physiotherapist, and targeted the participating 4- and 5-year-old children, their parents and their preschool teachers.

The children received a daily 30-minutes physical activity lesson offered by the preschool teachers. The standardized structure contained an initial ritual, following an introduction period that was coordinated with the main section where the preschool teachers were asked to encourage the children in using and developing their motor skills attending to joyful games and exercise tasks. After a cool-down, a short feedback round closed the lesson. All contents of the lessons were child-appropriate, based on the holistic domain of psychomotor approach, easy to teach by the preschool teachers, and easily established in the preschools irrespective of their equipment, personnel and/or space. The main focus of the activity lessons was to enhance coordinative skills and perception (optical, acoustical, tactile, vestibular, kinesthetic). The teachers were encouraged to adjust lessons according to children's abilities, interests and ideas. Preschool teachers received a collection of games and exercise tasks developed to plan and organize the daily physical activity lessons, and a manual including pedagogical, didactical and methodological background information. These materials were free of costs for the preschools. Teachers were trained in two workshops and regularly supervised, whenever there was a need, at least once eight weeks.

To encourage physical activity of the children and their families during leisure time, the children received physical activity homework cards once or twice per week and, for holidays seasonal letters comprising games and exercises to be performed by the child with or without other family members or friends. The games and tasks were designed to be joyful and foster an active lifestyle of the whole family.

Parents were invited to three interactive lectures that provided information and exchange on healthy development and promotion of motor skills in childhood. Furthermore, principles of a healthy nutrition, limited media use, and the importance of physical activity in early years were discussed. Flyers summarizing the information were provided at each meeting.

Outcome measures

Assessments were performed at baseline (summer 2007), at about half time during the intervention period (winter 2007/2008), at the end of the intervention (summer 2008), and two to four months after the end of intervention (autumn 2008). Motor skill assessments were performed in the gyms or large rooms of the preschools. Assessment of height, weight and skinfold thickness took place in a separate room. Physical activity was measured objectively by accelerometry over a full week including times outside the preschool. All outcome measures were taken by trained researchers blinded to group assignment of the children. Additional details on the outcome measurements were previously described (34). Briefly, the PAKT project had two primary outcomes: 1) change in percentage of (wearing) time spent in moderate-and-vigorous physical activity (MVPA, cut-point: 420 counts/15 seconds according to Pate and colleagues (28)) and 2) change in a composite motor skill score calculated by a mean z-score of an obstacle course (20), standing on one foot (modified) (6), a standing long jump (6), and

jumping to and fro sidewise (6). Agility of the child was assessed by an obstacle course. The child was asked to manage a distance between a marking point and a bench, climbing over and crawling under the bench, and to pass the course two more times. Time was taken in seconds. Explosive leg strength was measured by the standing long jump task. With this task the maximum distance a child jumped from both feet was taken in centimeters. The balancing on one foot task assessed static balance ability by assessing the amount of penalty points contacting the ground with the free leg while balancing with the other foot on a 4.5 cm width bar. By the jumping to and fro sidewise task jumping coordination ability was assessed from the child. Therefore, the child was asked to jump sidewise with both feet as often as possible for 15 seconds. Sum of valid jumps from two attempts were taken.

As the results of a throwing ability (48) and a balancing backwards task (48) were documented in an ordinal scale they were not included into the motor skill score. For physical activity inclusion criteria was a minimum wearing time of 7 hours per day on at least 3 valid weekdays and 1 valid weekend day. Data on time spent in MVPA was calculated as average time related to individual wearing time per day.

Secondary outcomes included the changes in percentage time spent in MVPA and the composite motor skill score between baseline and at the follow-up (two to four months after intervention), and the changes in single motor performance tasks including the obstacle course, one foot stand, balancing backwards (48), standing long jump, jumping to and fro sidewise, and target throw (48) at all-time points. Secondary outcomes also included age and sex related body mass index (19), blood pressure and sum of four skinfolds (triceps, biceps, subscapular, suprailiac), as well

as frequency of accidents and infections, that were assessed by the parents with a semi qualitative questionnaire (34).

For descriptive analyses, socio-economic status (SES) and migrant status was assessed by questionnaire for the parents (22). Children were categorized into three groups of SES (low, middle, high) using the Winkler Index (45).

Statistical methods

All analyses were performed with IBM SPSS 21 if not stated otherwise. With a postulated group difference of 0.6 standard deviations we calculated that a total of 348 children would provide a power of $\beta=0.80$ to detect relevant preventive effects between participants of the intervention and the control group at a Bonferroni adjusted significance level of 0.025 for two primary outcomes. In this calculation we accounted for possible missing data because of total drop out, missing a testing appointment or non-participation of participants and for incomplete data in accelerometry. Furthermore, assuming an intraclass correlation of $\rho = 0.1$ and an average cluster size of 17 children per preschool we accounted for random cluster effect.

Statistical analyses were based on the intention-to-treat principle. Results are reported at the level of individuals. Data are described by means (M) and standard deviations (SD) or percentages. To document representativeness of our sample anthropometry at baseline of the PAKT sample was compared to the national representative distribution in BMI for 3- to 6-years olds based on Kurth and Schaffrath Rosario (21) by chi square test.

For analyzing motor skill performance a composite motor skills score was calculated by summing up the z-transformed changes of the obstacle course, standing long jump, balancing on one foot, and the jumping to and fro sidewise tasks based on the total sample at each time point.

Prior to this, the values of the balancing task and of the obstacle course were multiplied by “-1” to account for the fact that a low score in these tasks indicates a better performance.

Baseline data were analyzed by descriptive statistics and differences in values at interval scale between intervention and control group by mixed model analysis of covariance with group (intervention versus control), sex, and urban/rural location of the preschool as fixed factors, preschool (cluster) as random factor, and age as covariate. For outcome variables at ordinal scale (balancing backwards, target throw, infections, and accidents) dummy variables with a yes/no or failure/passed option were computed. Intervention effects were analyzed by a repeated measurement analysis of covariance with the changes from baseline to the two assessments during the intervention period as dependent variables with adjustment for group (intervention versus control), sex, and urban/rural location of the preschool as fixed factors, preschool (cluster) as random factor, and age and baseline outcomes as covariates. The same statistical model was used for the secondary outcome variables in an exploratory manner. The changes in MVPA, composite motor skill score and the secondary outcome variables between baseline and follow up was analyzed by the statistical model described above including the values of the two time points baseline and follow up testing. Effect estimates describe the difference between the mean changes in the intervention group over controls with 95% confidence intervals (CI).

Additional exploratory analyses

Subsidiary analyses were performed using the statistical model outlined above. These analyses assessed the differences in MVPA between groups separately on weekdays (Monday through Friday) and weekends and the effect of the intervention on BMI centile and the sum of skinfold thickness in the subgroup of overweight children (BMI>90thcentile) (19).

Results

Baseline data

Table 1 summarizes children's characteristics and baseline primary and secondary outcome variables according to group assignment. There were no significant differences between the groups at baseline.

Only 5.5% (n=39) of all children (5.3% boys and 5.7% girls) were overweight or obese. Compared to a nationally representative sample of 3836 3- to 6-years olds with a prevalence of overweight and obese children of 9.1%, our sample had significantly less overweight or obese preschool children ($X^2=9.893$, $df=1$, $p=0.002$) (19, 21).

Primary outcomes

The changes in primary outcomes are presented in figures 3 and 4. At baseline, there were no significant differences in MVPA (IG: $14\pm4\%$; CG: $14\pm4\%$) or in the composite motor skill score (IG: -0.03 ± 3.18 ; CG: 0.03 ± 3.07) between the two groups. The intervention group showed a higher increase in proportion of daily time spent in MVPA compared to controls (effect estimate of 0.005 (95% CI: -0.00002 to 0.0101; p-value: 0.049) at the end of intervention which was – due to Bonferroni adjustment of the alpha level – close to statistical significance. In contrast, the intervention induced a statistically significant increase in the composite motor skill score with children in the intervention group showing a higher motor skill performance than the control group with an estimated z-score difference of 0.623 (p-value: 0.001, 95% CI: 0.276 to 0.975).

Secondary outcomes

Table 2 presents changes in secondary outcomes during the intervention and follow up period. Compared to controls children in the intervention group showed significant improvements in explosive leg strength, jumping coordination, and static balance, but there were no significant improvements in agility, dynamic balancing or throwing ability.

The intervention did not lead to a significant difference between the intervention and control group in rates of accidents and infections. There was no significant effect of the intervention on changes in BMI centile or skinfold thickness, nor on systolic or diastolic blood pressure.

The effects in physical activity and the composite motor skill score from baseline to short-term follow up 2 to 4 months after the end of intervention are shown in figures 3 and 4. While there was no significant effect of intervention on objectively measured MVPA between baseline and follow-up (p-value: 0.859, estimate: 0.006, 95% CI: -0.006 to 0.007; mean change IG: 0.15 ± 0.37 ; mean change CG: 0.15 ± 0.04) (see figure 4), the increase in children's motor skill performance (motor skill z-score) in favor of the intervention persisted even 2 to 4 months after the end of intervention (p-value: 0.007, estimate: 0.590, 95% CI: 0.169 to 1.011; mean change IG: 0.309 ± 3.033 ; mean change CG: -0.374 ± 2.998) (see figure 3). Table 2 shows the changes in secondary outcomes at follow up assessment. Children in the intervention group showed significantly better improvements in agility and in explosive leg strength while positive effects on static balance did not persist. There was no effect of the intervention on further secondary outcomes.

Additional exploratory analyses

Additional analyses of children's MVPA separately for weekdays and for weekends showed that the children of the intervention group were significantly more active than the controls during weekdays (p-value: 0.003, estimate: 0.011, 95% CI: 0.004 to 0.018; mean change IG from baseline to post-intervention assessment: 0.021 ± 0.035 ; mean change CG from baseline to follow up: 0.009 ± 0.041), but there was no such difference in MVPA during weekends.

16 children in the control and 23 children in the intervention group were overweight or obese (> 90th. percentile for BMI) at baseline. While there was no significant interventional effect on BMI centile (p=0.054), we found significant beneficial effects of the intervention on the decrease in sum of four skinfolds at post-intervention in favor to the intervention group (-11.444 mm, 95% CI: -22.091 to -0.798, p-value: 0.036). However, this effect did not sustain at follow-up.

Discussion

Our randomized controlled, multi component physical activity intervention resulted in an improvement in motor skills performance at the end of the intervention. Children in the intervention group showed a 55% increase in motor skills performance over children in the control group after intervention, which persisted with a slightly reduced benefit 2 to 4 months off intervention. Thus, we could provide evidence that motor skills performance in preschool children can be improved and maintained by an appropriate physical activity program in 4- to 5-year-old boys and girls. The program consisted of a daily 30 minutes physical activity intervention instructed by the preschool teachers over one preschool year, including physical activity homework for the children, informational meetings for parents, supervision and two

workshops for the preschool teachers. The intervention also included some information about healthy nutrition for children, media use and on how to establish an active family lifestyle.

Improvement in motor proficiency was based on statistically relevant benefits in static balance (standing on one foot), explosive leg strength (standing long jump) and jumping coordination (jumping to and fro sidewise) from baseline to post-intervention. Agility as a complex quality of motor control implies that contents of coordination and speed performance were improved at follow-up, suggesting that it may take some time to have sustained effects in preschoolers.

Most improvements in motor skills (explosive leg strength, jumping coordination and agility) gained with the intervention were sustained 2 to 4 months later with the exception of static balance and jumping coordination. It seems that permanent involvement in motor skills training is necessary for children to achieve benefits in static balance and jumping coordination skills. As these tasks require a high level of concentration and coordination they may need persistent training to maintain improvements. Although previous research has indicated that children with advanced motor skills may have benefits in cognitive development and academic performance, one has to acknowledge that this assumption was based on cross-sectional study results (11). Provided that balancing skills are related to cognitive performances, intervention effects on balancing abilities may be influenced by improvement in attentiveness (7).

Children in the intervention group showed a trend of being physically more active than the control group as differences in change were of borderline statistical significance. Although the magnitude of the difference of increase observed among the groups is small, data need to be interpreted in the context of two considerations: First, physical activity baseline data in our sample showed that the children spent already a relatively high proportion of their time in MVPA with a mean of 14% of their daily measurement time or approximately 1 hour and 20

minutes of MVPA per day. Second, physical activity guidelines for preschool children recommend a minimum of 60 minutes MVPA per day (39, 43). In the light of the fact that data of our sample showed that 93.5% of the children meet these guidelines at baseline assessment, there was a high level of physical activity in our sample, although this high ratio of active children might be fostered by the low cut-off of moderate-and-vigorous physical activity we used (28). Despite these characteristics MVPA increased in the intervention group up to about 15% of total daily measurement time. Furthermore, we could show by exploratory analyses that physical activity of the children could be significantly increased during weekdays (estimate: 1.1%, 95% CI: 0.4 to 1.8%). In more specific terms, this means that children spent about 36 minutes more time in MVPA total recording time per week under intervention. Moreover, the intervention did not result in an increase in MVPA on weekend days. Based on the Activity stat hypothesis, which suggests generally stable levels of physical activity in children (10), there should have been a compensatory decrease in MVPA on days off intervention to maintain an overall level of physical activity. Our study suggests that there is no “Activity stat” in preschool children and levels in MVPA can be improved by a child-appropriate intervention. Yet, already 2 to 4 months after end of intervention benefits in physical activity in favor of the intervention group did not sustain. This effect is not easy to explain as a long-term follow-up study (3) revealed motor skill development in childhood to be the key in long-term physical activity. Thus, improvement of motor proficiency in childhood as found in our study could be expected to have public health impact, despite a minor intervention effect on physical activity. It may be that the short time of follow-up in our study was not sufficient to reveal a longitudinal effect of enhanced motor proficiency on physical activity in children, especially since start of primary school in many of

our study participants may have confounded the effects. Further longitudinal research is necessary to clarify associations between motor skills and physical activity in young children.

There were no considerable changes in any other health related outcome variables such as BMI percentile, sum of skinfold thickness, rate of accidents or infections, and blood pressure. One has to bear in mind though that we dealt with a quite healthy population and prevalence of overweight or obesity as well as the mean BMI percentile of the sample was low at baseline. Lowering the BMI of the children is therefore not needed for this sample. Nevertheless, it is reassuring that our population at risk did show a change in sum of four skinfolds which was reduced by 11.4 mm in the obese children of the intervention group compared to controls. This result indicates that obese children reduced body fat under intervention and underlines the importance of measuring skinfold thickness rather than BMI as a more valid predictor for relative body fat in children (5). Such a benefit in children with special risks is of clinical importance especially when considering that obesity in childhood is the most important predictor of adult obesity (15) and that loss of adiposity from childhood to adulthood results in substantially low risks of type 2 diabetes, hypertension, and lipid abnormalities (16).

Strengths and limitations

Strengths of the present study represent having established a relevant and efficacious lifestyle intervention in preschoolers that is low-cost and easy to implement into the health systems as it is joyful, child appropriate and taught by preschool teachers. Moreover projects including repeated measures of outcome variables in the current field of preschool intervention studies are rare and results were almost invariably based on an isolated pre-post-testing. It has been suggested that repeated measures of multiple outcome variables are necessary for valid analysis of the results of

an intervention (36, 41). Our measures at mid-intervention fostered the validity of our results and the inclusion of a short term follow-up 2 to 4 months after the end of intervention revealed stability and persistence of the intervention effects with respect to motor skills.

We have designed and implemented a multi-component intervention to promote physical activity in the preschool settings including families. The inclusion of a collection of games and exercises as well as the manual for the preschool teachers providing comprehensive information and description of the program this project can be easily transferred to other preschool settings. The strategies used in the project empowered the preschool teachers to organise the lessons on their own and allows for individual enhancements which might be a key for motivation of all parties involved to take ownership of the intervention and process change (13). All participating preschools completed the two workshops with at least one, or up to four teachers of the preschools in the intervention group. Finally, the large sample size in the study, a broad and objective assessment of outcome measures and the use of multilevel analyses adds to the rigour of our methodology.

Despite these strengths, we acknowledge some study limitations. For some relevant outcome measures our sample may not be representative. Our sample showed a significantly low prevalence (<10%) of overweight and obesity compared to the national distribution (19), suggesting some selection bias. Active families may have been more motivated to join a study with a physical activity intervention than those who do not favor an active and healthy lifestyle. Unfortunately, we have no information about the non-participating children within the consenting preschools. Furthermore, although efforts were made to blind the children in the control group to the existence of the intervention arm (there was no information given by the study personal, nor were media informed about the intervention project), one cannot forget that

preschool teachers or parents might have given information to children and data may be affected by some bias. Nevertheless, as we could see that physical activity of the children in the control group did not increase from baseline to mid-term assessment, this bias might be very small.

Additionally, the focus of the intervention on health status and sedentary behavior of the children was realized with small amount of informational material and seminars for the parents. And, parental participation in informational lectures was decreasing by the end of the project. While 326 persons took part in the first informational lecture, 155 visited the second, and only 22 joined the third one. Thus, these components of the intervention probably provided only a low dose to change behavior and have any beneficial impact on most of our measured secondary outcomes. Nevertheless, most secondary outcome results were in normal range and should be maintained rather than improved. Future projects should focus a participatory intervention strategy arm targeting parents to foster effects on children's health markers.

Finally, our intervention project addressed only children for whom we had parental approval for participation. The key question is on how to involve all children within the preschools into such programs, as it is a well-known principle in prevention that if the program is voluntary, the population that needs it most and is at risk is not participating (17). The ideal Public Health solution would be to make physical activity promotion an integral part of health education policies of preschools as suggested (29).

Comparison with previous preschool intervention studies

In the present study, we confirm earlier findings that motor skill performance can be improved by a physical activity intervention. Several studies aimed to increase fundamental motor skills in preschool children (24, 31, 33). Most of them evaluated the effects with a pre-post-analysis, only

few integrating a follow-up assessment, and none of them applied a mid-term test and a follow-up. Although most of the previous projects led to an improvement in at least some motor skills in preschool children, not all of them have shown success (24, 33). From a Public Health perspective, we have ample evidence of short-term post intervention effects of lifestyle interventions, but evidence about persisting effects beyond the intervention period is still lacking. Our study shows not only that motor skill performance can be improved by a joyful intervention in preschools but also that benefits persist, at least in the short run.

Several randomized controlled trials in preschool children have aimed to increase physical activity with a child-care based, structured physical activity intervention program (1, 2, 4, 26, 31). As findings from reviews are divergent due to a large variability in quality, methods and/or theory of the included studies and/or focus on different populations, evidence of the effects of interventions on physical activity in preschool children is generally lacking there (26). The physical activity intervention in our project was based on a holistic pedagogic approach that aims to assist children in their motor development emphasizing their self-competence and self-efficacy (47). As addressed in previous studies, such a participatory approach and a foundation on self-regulation skills could be a key factor in achieving an effect on physical activity in preschool age (13). Our study did not lead to a significant increase in MVPA overall. Given that we had a relatively “active” population at baseline and that there was a significant beneficial effect of the intervention on weekday physical activity, it is reasonable to postulate that physical activity behavior may be improved by child-appropriate interventions. However, further research is needed on the role of mediators and moderators of a potential beneficial intervention effect on physical activity in preschool children.

There is some evidence from randomized, controlled trials that children being at special risk can benefit of lifestyle interventions (2, 8, 27, 31). One physical activity intervention, performed in a sample of African-Americans overweight children, reported a reduction in BMI of the intervention group, especially in those with an initially high BMI (2). Three studies revealed a beneficial effect on obesity markers like BMI, skinfold thickness, waist circumference, percentage of body fat, or prevalence of overweight participants in samples of migrant, minority, overweight or low socioeconomic status preschool children (8, 27, 31). With the results of our study we are in line with these findings as we found a reduced increase in sum of skinfolds in a subsample of overweight children that persisted even after the intervention.

Conclusions

In conclusion, our results indicate that the PAKT prevention program led to a sustained improvement in motor skill performance, but not in overall physical activity or other health related behavioral patterns in healthy 4- to 5-year old children. Considering the few promising results of long term intervention studies with less standardized intervention contents focusing motor skills, our results are encouraging. We provided evidence, that the program can be implemented by the preschool teachers without further costs, is in line with a holistic preschool developmental policy and feasible independently of resources in personal or space of preschools. Future research with the evaluation of long-term effects of preschool-based, child-appropriate physical activity interventions is needed to gain knowledge whether such programs lead to long-term behavioral changes in motor skill performance that will ultimately transfer into a sustained health.

Acknowledgements

We thank Sonja Mauer, University Children's Hospital, and Matthias Obinger, Institute of Sports and Sport Science University Wuerzburg, for their research assistance, and Thomas Schenk, Department of Anaesthesiology, University Hospital Wuerzburg, for his support regarding analysis of the physical activity data. And we thank all the children, their parents and preschool teachers as well as the supporting organizations of the preschools for their cooperation in the project.

Conflict of interest

The authors declare that the institution of HH, KCR and KR had financial support from the German Federal Ministry of Education and Research (BMBF) (Grant Nr. 01EL0606, BMBF) and from the BARMER GEK (formerly Gmuender Ersatz-Kasse GEK) for the submitted project. The funders had no role in study design, data collection and analysis, decision to publish, or preparation of the manuscript. There are no financial relationships with any organizations that might have an interest in the submitted work in the previous three years, and no other relationships or activities that could appear to have influenced the submitted work. We declare that the results of our study do not constitute endorsement by ACSM.

References

1. Alhassan S, Nwaokelemeh O, Ghazarian M, Roberts J, Mendoza A, and Shitole S. Effects of locomotor skill program on minority preschoolers' physical activity levels. *Pediatr Exerc Sci*. 2012;24(3):435-49.
2. Annesi JJ, Smith AE, and Tennant GA. Effects of the Start For Life treatment on physical activity in primarily African American preschool children of ages 3-5 years. *Psychology, health & medicine*. 2013;18(3):300-9.
3. Barnett LM, van Beurden E, Morgan PJ, Brooks LO, and Beard JR. Childhood motor skill proficiency as a predictor of adolescent physical activity. *The Journal of adolescent health : official publication of the Society for Adolescent Medicine*. 2009;44(3):252-9.
4. Bellows LL, Davies PL, Anderson J, and Kennedy C. Effectiveness of a physical activity intervention for Head Start preschoolers: a randomized intervention study. *Am J Occup Ther*. 2013;67(1):28-36.
5. Boeke CE, Oken E, Kleinman KP, Rifas-Shiman SL, Taveras EM, and Gillman MW. Correlations among adiposity measures in school-aged children. *BMC pediatrics*. 2013;13:99.
6. Bös K BS, Tittlbach S, and Woll A. Karlsruher Motorik-Screening für Kindergartenkinder (KMS 3 - 6) [Karlsruhe Motor-Screening for preschool children (KMS 3-6)]. *Sportunterricht*. 2004;53:79-87.
7. Fisher A, Boyle JM, Paton JY et al. Effects of a physical education intervention on cognitive function in young children: randomized controlled pilot study. *BMC pediatrics*. 2011;11:97.

8. Fitzgibbon ML, Stolley MR, Schiffer L, Van Horn L, KauferChristoffel K, and Dyer A. Two-year follow-up results for Hip-Hop to Health Jr.: a randomized controlled trial for overweight prevention in preschool minority children. *The Journal of pediatrics*. 2005;146(5):618-25.
9. Goldfield GS, Harvey A, Grattan K, and Adamo KB. Physical activity promotion in the preschool years: a critical period to intervene. *International journal of environmental research and public health*. 2012;9(4):1326-42.
10. Gomersall SR, Rowlands AV, English C, Maher C, and Olds TS. The ActivityStat hypothesis: the concept, the evidence and the methodologies. *Sports medicine*. 2013;43(2):135-49.
11. Haapala EA. Cardiorespiratory fitness and motor skills in relation to cognition and academic performance in children - a review. *Journal of human kinetics*. 2013;36:55-68.
12. Hardy LL, King L, Kelly B, Farrell L, and Howlett S. Munch and More: evaluation of a preschool healthy eating and movement skill program. *Int J Behav Nutr Phys Act*. 2010;7:80.
13. Jagosh J, Macaulay AC, Pluye P et al. Uncovering the benefits of participatory research: implications of a realist review for health research and practice. *The Milbank quarterly*. 2012;90(2):311-46.
14. Jones RA, Riethmuller A, Hesketh K, Trezise J, Batterham M, and Okely AD. Promoting fundamental movement skill development and physical activity in early childhood settings: a cluster randomized controlled trial. *Pediatr Exerc Sci*. 2011;23(4):600-15.

15. Juonala M, Juhola J, Magnussen CG et al. Childhood environmental and genetic predictors of adulthood obesity: the cardiovascular risk in young Finns study. *The Journal of clinical endocrinology and metabolism*. 2011;96(9):E1542-9.
16. Juonala M, Magnussen CG, Berenson GS et al. Childhood adiposity, adult adiposity, and cardiovascular risk factors. *The New England journal of medicine*. 2011;365(20):1876-85.
17. Koopmans B, Nielen MM, Schellevis FG, and Korevaar JC. Non-participation in population-based disease prevention programs in general practice. *BMC public health*. 2012;12:856.
18. Kordi R, Nourian R, Ghayour M, Kordi M, and Younesian A. Development and evaluation of a basic physical and sports activity program for preschool children in nursery schools in Iran: an interventional study. *Iran J Pediatr*. 2012;22(3):357-63.
19. Kromeyer-Hauschild K, Wabitsch M, Kunze D et al. [Body Mass Index percentiles for children and adolescents based on multiple German samples.] *Monatschr Kinderheilk* 2001;149:807-18.
20. Kunz T. [*Psychomotor training - a new way to prevent accidents in preschools.*] Frankfurt am Main: Bundesverband der Unfallversicherungsträger der öffentl. Hand; 1990.
21. Kurth BM, and Schaffrath Rosario A. [The prevalence of overweight and obese children and adolescents living in Germany. Results of the German Health Interview and Examination Survey for Children and Adolescents (KiGGS)]. *Bundesgesundheitsblatt, Gesundheitsforschung, Gesundheitsschutz*. 2007;50(5-6):736-43.

22. Lange M, Kamtsiuris P, Lange C et al. [Sociodemographic characteristics in the German Health Interview and Examination Survey for Children and Adolescents (KiGGS) - operationalisation and public health significance, taking as an example the assessment of general state of health]. *Bundesgesundheitsblatt, Gesundheitsforschung, Gesundheitsschutz*. 2007;50(5-6):578-89.
23. Lebensmittelsicherheit BLfGu [Food safety]. [*Health in preschool children in Bavaria - Results of the health examination for school entry 2004/2005 - Statistical epidemiological report*]. Erlangen 2006.
24. Logan SW, Robinson LE, Wilson AE, and Lucas WA. Getting the fundamentals of movement: a meta-analysis of the effectiveness of motor skill interventions in children. *Child: care, health and development*. 2012;38(3):305-15.
25. Lubans DR, Morgan PJ, Cliff DP, Barnett LM, and Okely AD. Fundamental movement skills in children and adolescents: review of associated health benefits. *Sports medicine*. 2010;40(12):1019-35.
26. Mehtala MA, Saakslähti AK, Inkinen ME, and Poskiparta ME. A socio-ecological approach to physical activity interventions in childcare: a systematic review. *The international journal of behavioral nutrition and physical activity*. 2014;11:22.
27. Nemet D, Geva D, and Eliakim A. Health promotion intervention in low socioeconomic kindergarten children. *The Journal of pediatrics*. 2011;158(5):796-801 e1.
28. Pate RR, Almeida MJ, McIver KL, Pfeiffer KA, and Dowda M. Validation and calibration of an accelerometer in preschool children. *Obesity*. 2006;14(11):2000-6.
29. Pate RR, Pfeiffer KA, Trost SG, Ziegler P, and Dowda M. Physical activity among children attending preschools. *Pediatrics*. 2004;114(5):1258-63.

30. Piek JP, Barrett NC, Smith LM, Rigoli D, and Gasson N. Do motor skills in infancy and early childhood predict anxious and depressive symptomatology at school age? *Human movement science*. 2010;29(5):777-86.
31. Puder JJ, Marques-Vidal P, Schindler C et al. Effect of multidimensional lifestyle intervention on fitness and adiposity in predominantly migrant preschool children (Ballabeina): cluster randomised controlled trial. *Bmj*. 2011;343:d6195.
32. Rhemtulla M, and Tucker-Drob EM. Correlated longitudinal changes across linguistic, achievement, and psychomotor domains in early childhood: evidence for a global dimension of development. *Developmental science*. 2011;14(5):1245-54.
33. Riethmuller AM, Jones R, and Okely AD. Efficacy of interventions to improve motor development in young children: a systematic review. *Pediatrics*. 2009;124(4):e782-92.
34. Roth K, Mauer S, Obinger M et al. Prevention through Activity in Kindergarten Trial (PAKT): a cluster randomised controlled trial to assess the effects of an activity intervention in preschool children. *BMC public health*. 2010;10:410.
35. Roth K, Mauer S, Obinger M, Lenz D, and Hebestreit H Activity and health prevention in preschools – Contents of an activity based intervention programme (PAKT – Prevention through Activity in Kindergarten Trial). *Journal of Public Health*. 2011;19(4):293-303.
36. Smedslund G, Zangi HA, Mowinckel P, and Hagen KB. Two to five repeated measurements per patient reduced the required sample size considerably in a randomized clinical trial for patients with inflammatory rheumatic diseases. *BMC research notes*. 2013;6:37.

37. Stodden DF, Goodway J, Langendorfer SJ et al. A developmental perspective on the role of motor skill competence and physical activity: An emergent relationship. *Quest*. 2008;60(2):290-306.
38. Timmons BW, Leblanc AG, Carson V et al. Systematic review of physical activity and health in the early years (aged 0-4 years). *Applied physiology, nutrition, and metabolism = Physiologie appliquee, nutrition et metabolisme*. 2012;37(4):773-92.
39. Tremblay MS, Leblanc AG, Carson V et al. Canadian Sedentary Behaviour Guidelines for the Early Years (aged 0-4 years). *Applied physiology, nutrition, and metabolism = Physiologie appliquee, nutrition et metabolisme*. 2012;37(2):370-91.
40. Vedula-Kjelsas V, Sigmundsson H, Stensdotter AK, and Haga M. The relationship between motor competence, physical fitness and self-perception in children. *Child: care, health and development*. 2012;38(3):394-402.
41. Vickers AJ. How many repeated measures in repeated measures designs? Statistical issues for comparative trials. *BMC medical research methodology*. 2003;3:22.
42. Ward DS, Vaughn A, McWilliams C, and Hales D. Interventions for increasing physical activity at child care. *Medicine and science in sports and exercise*. 2010;42(3):526-34.
43. WHO. *Global recommendations on physical activity for health*. World Health Organization. Geneva, Switzerland; 2010
44. Williams HG, Pfeiffer KA, O'Neill JR et al. Motor skill performance and physical activity in preschool children. *Obesity*. 2008;16(6):1421-6.
45. Winkler H, and Stolzenberg J. [The socio-economic status within the German Health Survey.] *Gesundheitswesen*. 1999;61(Sonderheft 2):178-83.

46. Zask A, Barnett LM, Rose L, O`Brooks L, Molyneux M, Hughes D, Adams J, and Salmo J. Three year follow-up of an early childhood intervention: is movement skill sustained?
Int J Behav Nutr Phys Act. 2012;9:127.
47. Zimmer R. [*Handbook of Psychomotoricity.*] Freiburg: Herber; 2006.
48. Zimmer R, and Volkamer M. [*MOT 4-6. Motor Test for 4- to 6-year old children. Manual.*] Weinheim: Beltz; 1987.

Figure Legends

Figure 1. Cluster and participant flow through the study. Inclusion criteria were health condition allowing unrestricted physical activity engagement of the children, an age of four or five years old with the start of the intervention program, and no existing formal physical activity promotion program in the preschool. Reasons for refusals to participate were leaving the preschool in near future (moving), lack of interest or time for passing a testing. ⁺ percentage of time spent in moderate-and-vigorous-physical-activity (MVPA) related to total recording time (objectively measured physical activity by accelerometry)

Figure 2. Number of study participants providing data for each outcome measures. ⁺ time spent in moderate-and-vigorous-physical-activity (MVPA) related to total recording time (objectively measured physical activity by accelerometry)

Figure 3. Adjusted moderate-to-vigorous physical activity in the-intervention and control group during study period. Values are reported as adjusted estimated marginal means (percentage MVPA of total wearing time)

Figure 4. Motor skill performance of the intervention and control group during the study period. Values are reported as adjusted estimated marginal means (motor skill z-score value)

Figure 1

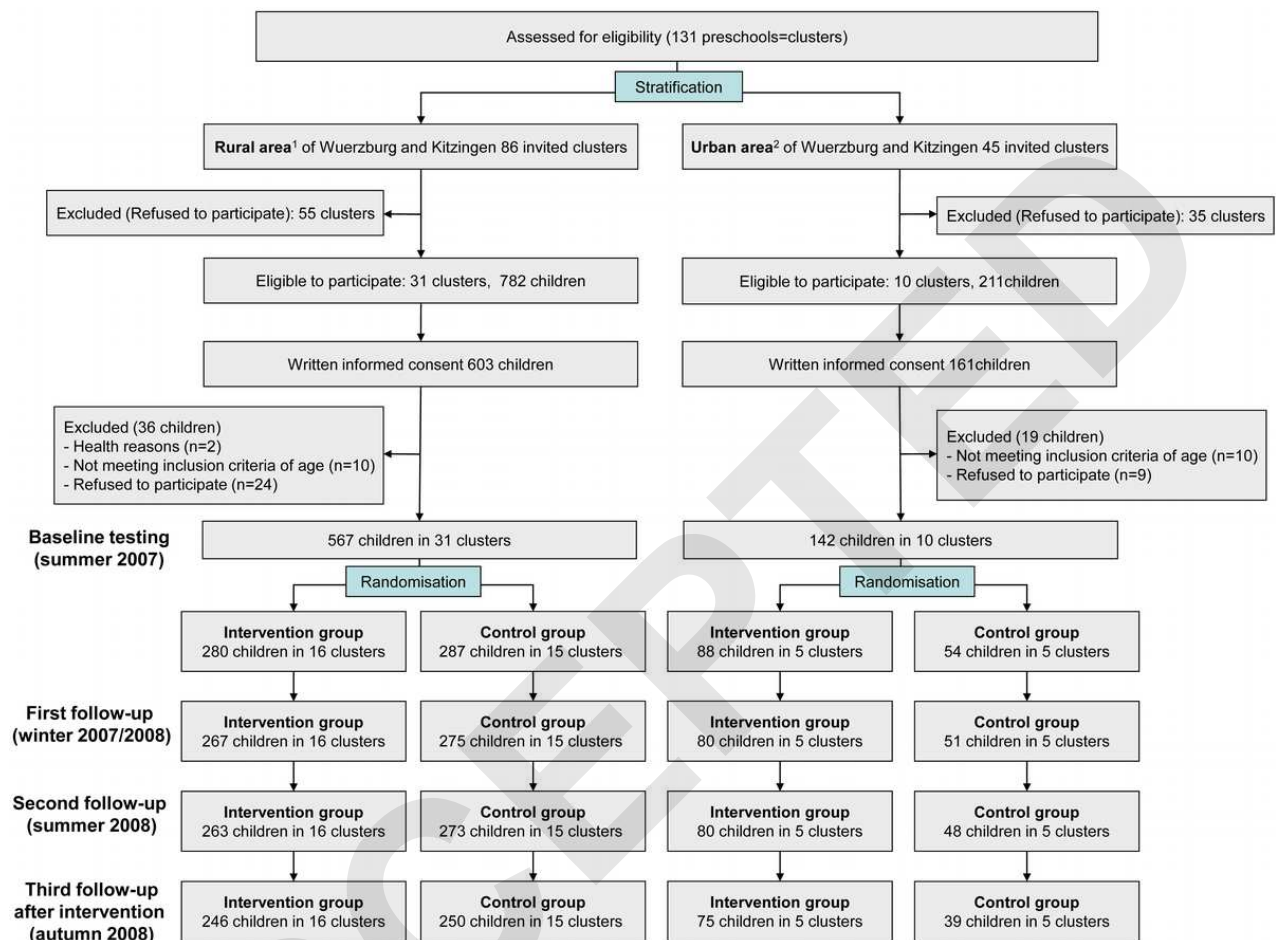


Figure 2

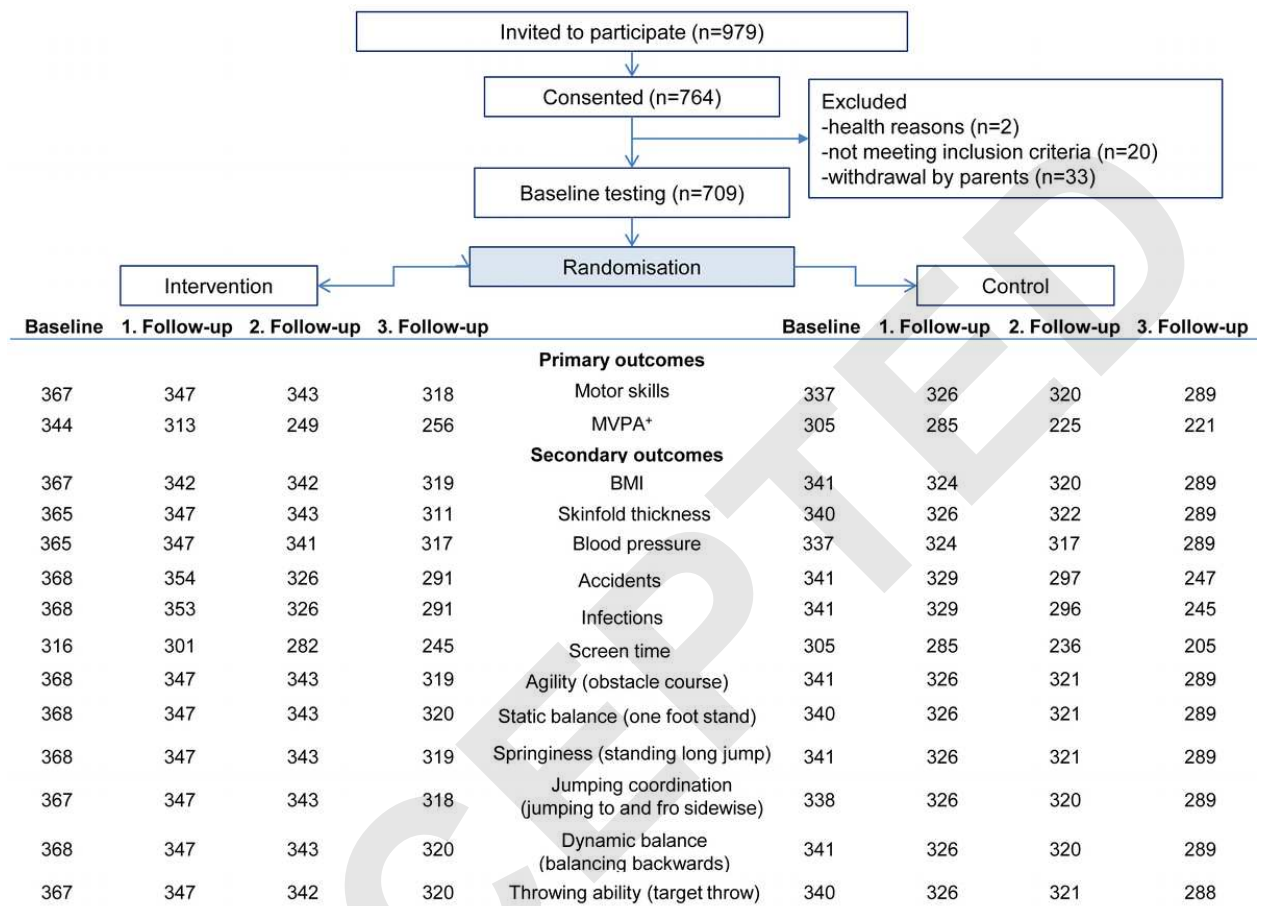


Figure 3

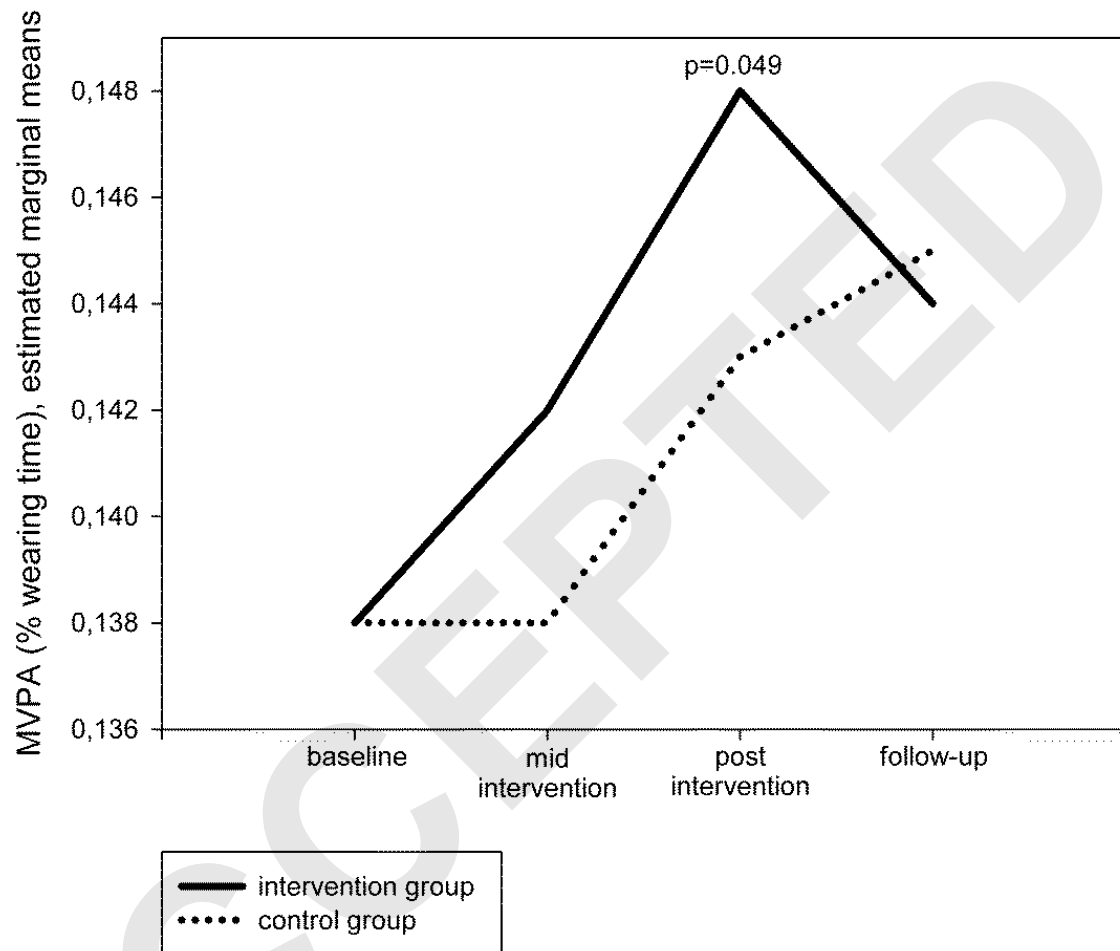


Figure 4

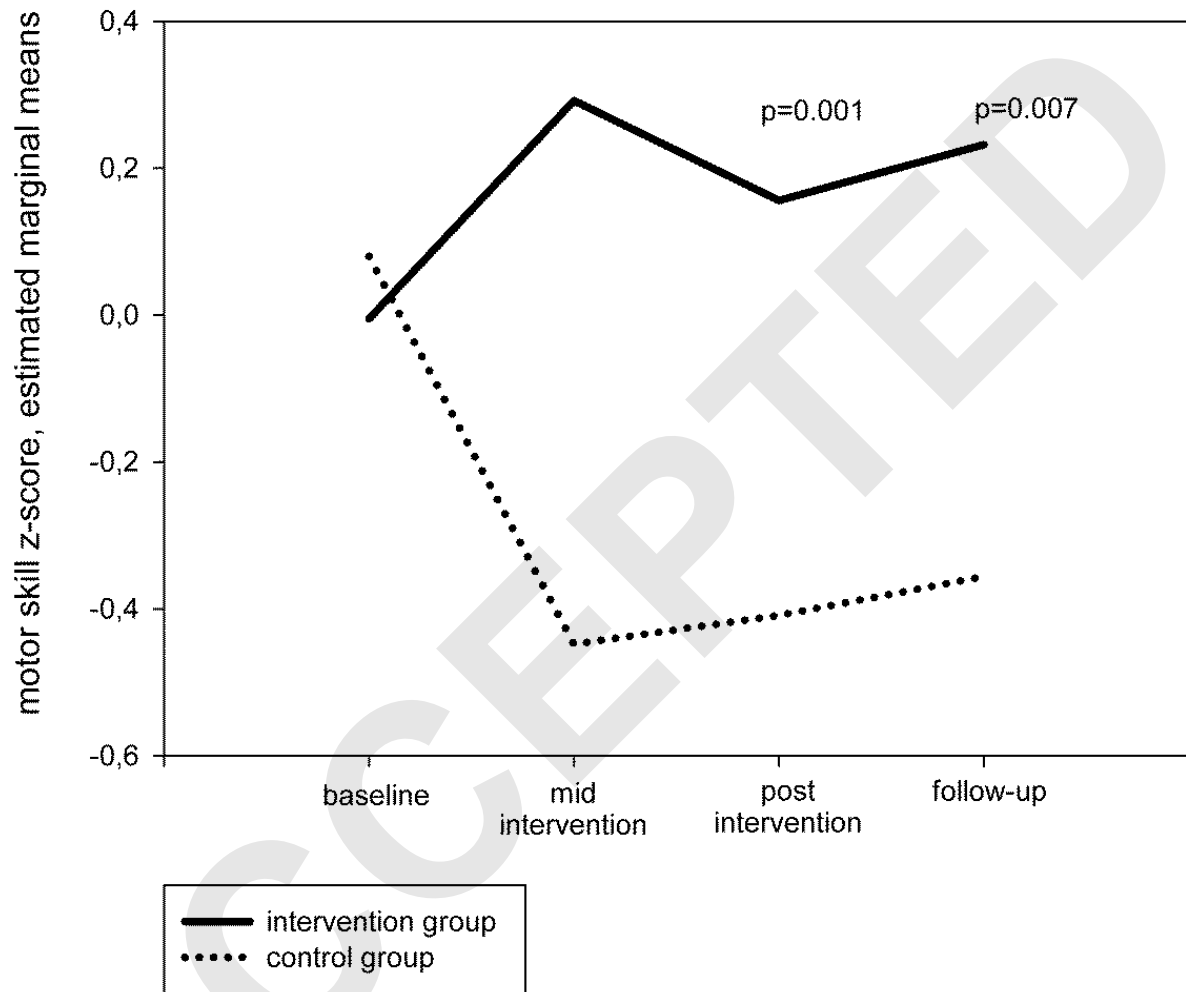


Table 1. Baseline characteristics of the children reported by parental questionnaire and for primary and secondary outcomes.

Characteristic/outcome	IG^a	CG^b
Girls n (%)	165 (47.6)	176 (51.6)
Age (years)	4.7±0.6	4.7±0.5
Low SES^c n (%)	81 (23.3)	64 (19.6)
Middle SES^c n (%)	174 (50.0)	164 (50.2)
High SES^c n (%)	93 (26.7)	99 (30.3)
Status of migration^d (%)	48 (13.1)	40 (11.8)
MVPA (% wearing time)^e	14.0±3.6	14.0±3.7
Motor skill proficiency (composite z-score)^e	-0.03±3.2	0.03±3.1
Agility (seconds)	26.8±9.5	26.4±8.2
Static balance (tips)	20.7±8.2	20.0±9.1
Explosive leg strength (cm)	81.6±19.9	81.0±20.0
Jumping coordination (jumps)	24.3±7.8	24.1±7.5
Dynamic balance n failure (%)	304 (82.6)	268 (78.6)
Throwing ability n failure (%)	257 (70.0)	249 (73.2)
BMI (centile)	46.5±26.2	48.5±25.4
Sum of four skinfolds (mm)	28.6±6.3	28.6±6.0

Systolic blood pressure (mmHg)	100.6±9.3	101.1±9.8
Diastolic blood pressure (mmHg)	60.3±8.3	60.3±8.1
Accidents n (%)	10 (2.7)	5 (1.5)
Infections n (%)	27 (7.3)	29 (8.5)

There were no significant differences between the intervention and the control group.

Values are reported as means ± standard deviations unless stated otherwise. ^aIntervention group.

^bControl group. ^cAccording to Winkler-Index to categorize socio-economic status (SES) based on parental school and professional education, professional position and net household income (56). ^d defined by the migration of the child from a foreign country and a parent was not born in Germany or by migration of both parents into Germany or missing German citizenship by both parents (30). ^ePrimary outcome.

Table 2. Effects of the intervention on secondary outcomes according to group.

	mid inter-vention change from baseline		post inter-vention change from baseline		Effect estimate		follow up change from baseline		Effect estimate	
	IG ^a	CG ^b	IG ^a	CG ^b	Estimate (95 % CI)	p	IG ^a	CG ^b	Estimate (95 % CI)	p
Agility (seconds)	-5.61 ± 7.78	-4.51 ± 6.45	-7.59 ± 8.20	-6.78 ± 6.71	-0.628 (-1.284 to 0.028)	0.060	-8.87 ± 8.58	-7.85 ± 6.77	-0.689 (-1.324 to -0.055)	0.034
Static balance (tips)	-5.77 ± 8.49	-4.22 ± 8.97	-6.73 ± 9.00	-5.60 ± 9.31	-1.474 (-2.811 to - 0.136)	0.032	-10.24 ± 8.14	-9.79 ± 8.55	-0.306 (-1.580 to 0.967)	0.629
Explosive leg strength (cm)	9.58 ± 14.93	5.82 ± 15.49	19.92 ± 16.73	17.96 ± 16.02	3.209 (5.332 to 1.085)	0.004	21.29 ± 16.24	16.80 ± 16.32	4.041 (1.217 to - 6.865)	0.007
Jumping coordination (jumps)	5.42 ± 6.06	3.72 ± 5.79	8.53 ± 7.20	7.01 ± 6.24	1.451 (2.646 to 0.257)	0.019	10.58 ± 7.67	9.17 ± 6.94	1.276 (0.205 to 2.758)	0.089

Dynamic balance n (% failure)	-35 (-5.1)	-15 (-1.0)	-53 (-8.5)	-49 (-10.2)	-0.015 (-0.074 to 0.045)	0.617	-67 (-8.5)	-37 (1.3)	0.051 (-0.032 to 0.135)	0.220
Throwing ability n (% failure)	-28 (-4.0)	-38 (-8.5)	-67 (-14.4)	-73 (-18.4)	-0.020 (-0.076 to 0.035)	0.465	-106 (-22.8)	-106 (-23.5)	0.006 (-0.085 to 0.096)	0.898
BMI (centile)	-0.21 ± 12.87	-1.32 ± 13.28	-1.71 ± 13.61	-2.31 ± 14.33	0.244 (-2.475 to 2.962)	0.857	0.28 ± 14.20	-0.945 ± 15.63	0.103 (3.140 to 3.345)	0.949
Sum of four skinfolds (mm)	-3.25 ± 12.98	-1.23 ± 16.34	-3.96 ± 15.20	-3.62 ± 15.96	-1.548 (-4.364 to 1.268)	0.272	-6.16 ± 14.15	-6.33 ± 14.65	0.305 (2.856 to 3.466)	0.846
Systolic blood pressure (mmHg)	2.60 ± 10.48	2.20 ± 10.78	2.56 ± 11.07	1.24 ± 12.27	-0.069 (-1.635 to 1.498)	0.930	2.74 ± 10.24	3.16 ± 11.05	-0.719 (-2.067 to 0.629)	0.295
Diastolic blood pressure (mmHg)	-2.48 ± 9.54	-2.09 ± 8.84	-4.82 ± 9.48	-4.05 ± 9.90	-1.011 (-2.404 to 0.383)	0.150	-4.29 ± 9.70	-3.92 ± 9.56	0.186 (1.592 to 1.963)	0.833

Accidents n (%)	0 (0.0)	7 (2.1)	1 (0.7)	5 (1.9)	-0.004 (-0.026 to 0.019)	0.748	-3 (-0.3)	-2 (-0.3)	0.012 (-0.010 to 0.036)	0.273
Infections n (%)	43 (12.5)	51 (15.7)	12 (4.7)	8 (4.0)	-0.023 (-0.075 to 0.029)	0.369	-2 (-1.2)	-6 (-0.8)	0.001 (-0.067 to 0.068)	0.986

The table summarizes the changes from baseline to mid-intervention assessment and from baseline to post-intervention assessment, as well as from baseline to follow-up in motor proficiency (motor skill subtests), adiposity and health related outcomes. Values are reported as means \pm standard deviations unless stated otherwise. ^aIntervention group. ^bControl group.